

NASA  
Mars Exploration Program Update  
to the  
Planetary Science Subcommittee

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# The state-of-the-MEP today

## Our operational assets remain healthy and productive:

- ✓ MAVEN has successfully completed its prime science mission and is now continuing investigations in an extended mission
- ✓ Odyssey, our oldest Mars asset, continues to be healthy and contribute thermal imagery and data relay services
- ✓ MRO continues to provide invaluable reconnaissance imaging and mineralogical mapping, supporting science investigations, rover operations, and exploring potential human landing sites
- ✓ Opportunity continues to provide important ground truth data, recently scaling 30 deg slopes of Knudsen Ridge atop the southern flank of Marathon Valley, to investigate red zones
- ✓ Curiosity continues exploring Gale Crater, generating important insights into Martian chemistry
- ✓ Mars Express continues operating our collaborative deep radar sounder (MARSIS)

## M2020 development on-track and proceeding well:

- ✓ PDR successfully completed Feb 2016
- ✓ Heritage H/W fabrication underway; some delivered
- ✓ Sampling system development labs up and running

## We are meeting our foreign commitments:

- ✓ Our two Electra payloads on the TGO are ready for flight
- ✓ MOMA is proceeding in development for the ExoMars Lander

## Financially, the program is doing well:

- ✓ This fiscal year all our planned activities are funded
- ✓ Earlier this month the President's FY17 budget was released and Mars fared well again, supporting our development, operational, and future mission activities

Overall, the state-of-the-MEP is good

# M2020 Mission Overview



## LAUNCH

- MSL Class/Capability LV
- Period: Jul/Aug 2020

## CRUISE/APPROACH

- 7.5 month cruise
- Arrive Feb 2021

## ENTRY, DESCENT & LANDING

- MSL EDL system ([Range Trigger](#) and [TRN baselined](#)): guided entry and powered descent/Sky Crane
- 16 x 14 km landing ellipse (range trigger baselined)
- Access to landing sites  $\pm 30^\circ$  latitude,  $\leq -0.5$  km elevation
- Curiosity-class Rover

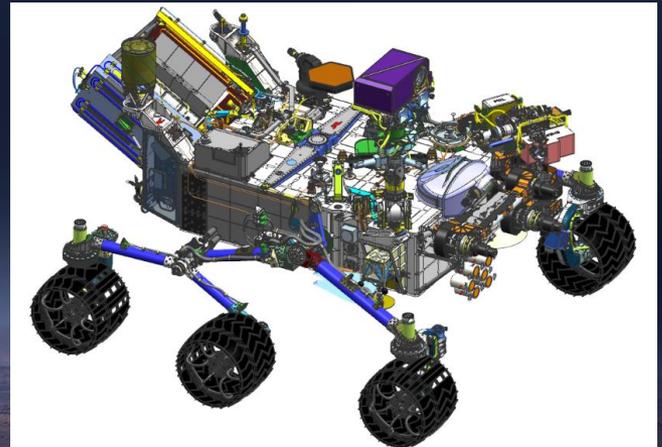
## SURFACE MISSION

- 20 km traverse distance capability
- [Enhanced surface productivity](#)
- [Qualified to 1.5 Martian year lifetime](#)
- Seeking signs of past life
- Returnable cache of samples
- Prepare for human exploration of Mars

M2020 mission elements

# M2020 Project Status Summary

- The Mars 2020 Project has conducted successfully the lower level instrument, subsystem, and Office level PDR's necessary to provide confidence in a full understanding of the requirements, design response, and associated cost estimates
- Cost estimates for new developments, particularly the instrument payload and SCS, include acceptable financial and schedule margins to support a 2020 launch
- The Mars 2020 Project has conducted successfully the mission system PDR
- Cost performance on heritage HW continues to perform under plan
- Project is progressing on-schedule within cost target



# PSS Findings from the October 5-6, 2015 re: Mars Orbiter

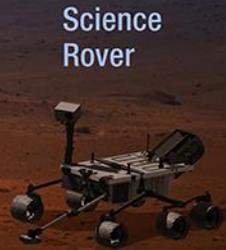
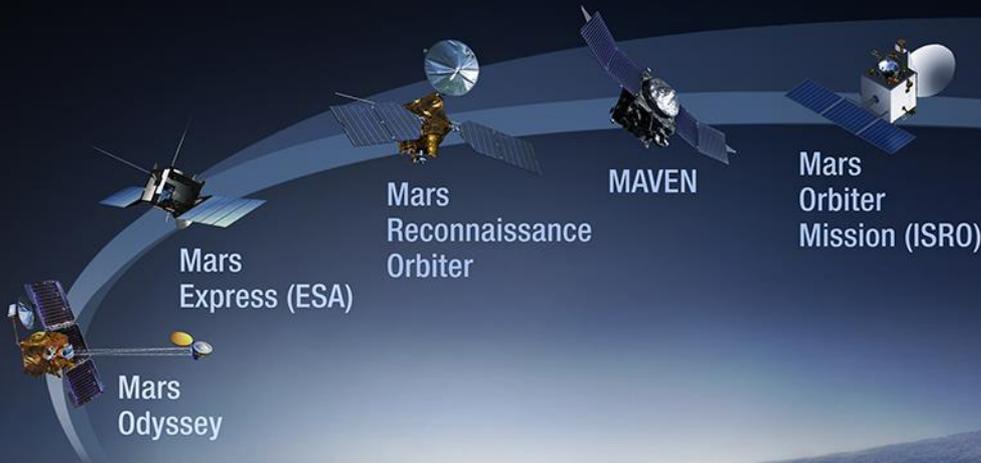
- **FINDING** - Preliminary information from a MEPAG science analysis group that studied functions for a Mars 2022 orbiter to be inserted into the overall plans for Mars exploration indicates a large and complex mission set merging goals of human exploration, technology demonstration, and planetary science. Coordination across multiple NASA Directorates will be necessary for funding the proposed mission architecture without placing an undue burden on other Planetary Science missions. At the next meeting of the PSS, we would like to hear details about the anticipated funding wedge and management plan for the currently envisioned set of highly collaborative missions on the path to humans at Mars.
- **RESPONSE** - While supportive of cross-directorate collaboration preparing for NASA's Journey to Mars, the President's FY2017 Budget provided funding to SMD to lead early work on a future Mars Orbiter focused on ensuring continuity of data relay capabilities for future Mars missions
  - Recognizing the strong need for such capability, MEP is targeting the earliest launch opportunity
  - Owing to the potential for substantial cost efficiency, formulation studies will consider enhancing the orbiter with scientific and exploration capabilities as has been our history, consistent with approved mission budget

Operational 2001–2015

2016

2018

2020



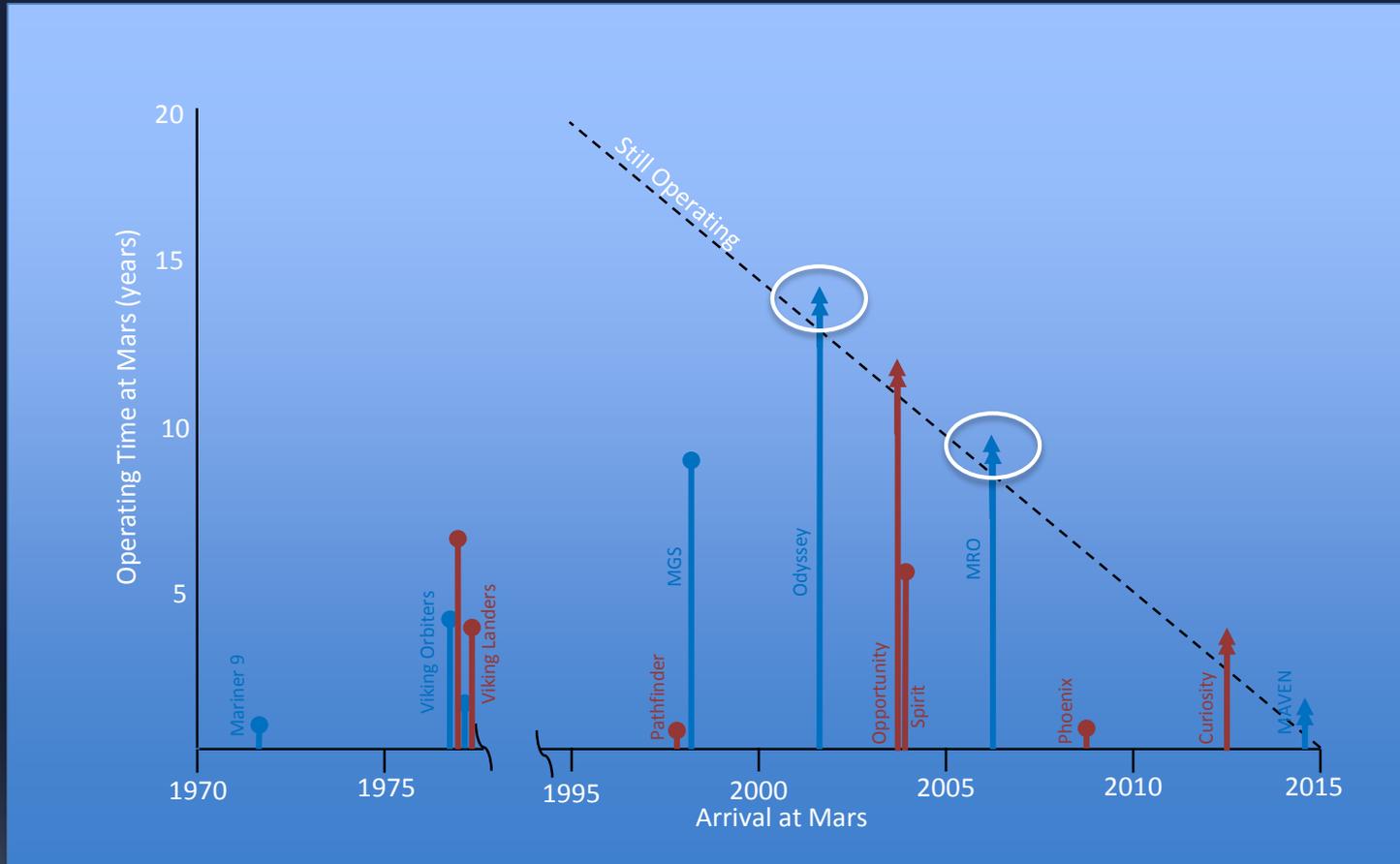
*Follow the Water*

*Explore Habitability*

*Seek Signs of Life*

*Prepare for Future Human Explorers*

# Operating At and Around Mars



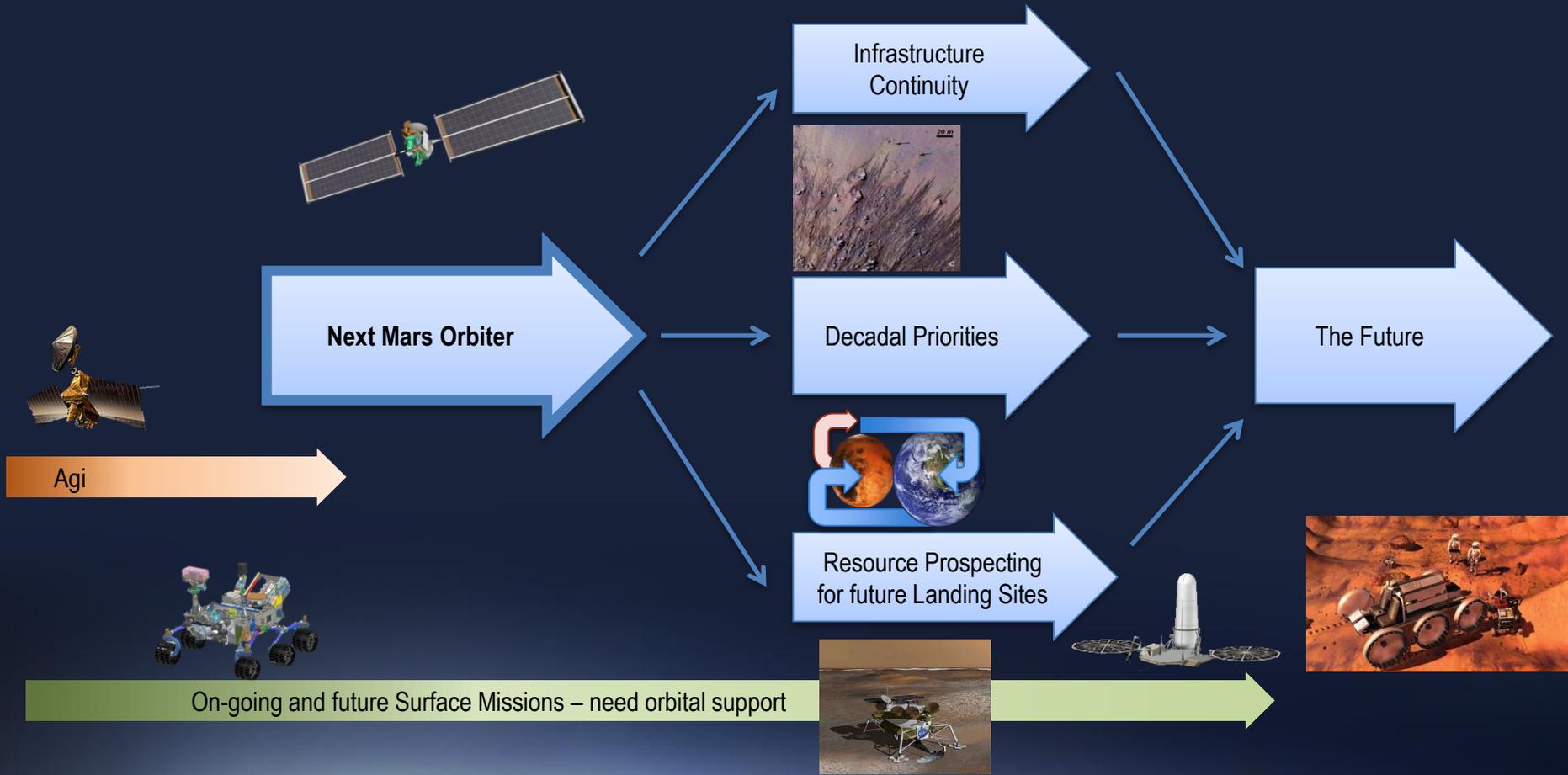
**MEP has operated successfully and with longevity, but our infrastructure is aging, placing the decade of the 2020s at risk**

# Strategic View Forward

- US National Research Council (NRC) Planetary Science Decadal Survey (2012) gave the highest priority to “elements of the Mars Sample Return Campaign”
- The Mars 2020 mission and its payload begin this process with the characterization of a site and the careful selection and documentation of a suite of samples acquired and encapsulated for return
- The President’s NASA Budget Request for FY2017 provides \$10M to begin early work on a future Mars orbiter missions beyond 2020 – with an emphasis on emplacing the infrastructure for the next decade

**MEP planning strives to integrate these realities into a viable plan for the future**

# Next Orbiter Can Provide Capabilities that enable Many Future Pathways



**Timely Renewal and Enhancement of Infrastructure is needed to Support Future Missions**

# Desired Orbiter Capabilities

## Renew and Update Aging Communications Infrastructure

- Essential to the future of Mars exploration; Laying the foundation for missions to come, while supporting ongoing missions in the early 2020's

## Provide Continuity of High Resolution Imaging

- Scientific Investigations for Landing Site Certification

## Essential Orbital Support for Sample Return

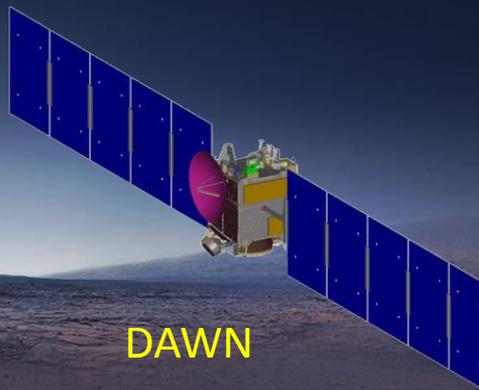
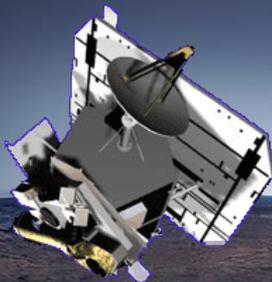
## Potential Resource Prospecting for future Landing Sites and Exploration planning

## Continuity of Relevant Remote Sensing

# Building from a Modest (Discovery-Class) Core Vehicle

- Many examples exist of architecturally flexible and adaptable spacecraft capable of supporting this mission
  - Provide Core Technical Functionality
    - Capable of Operating in Deep Space
    - Long Lifetime
    - Autonomous Operations
    - 3-axis pointing for imaging and communications
  - Adaptable to Solar Electric Propulsion, providing mission flexibility
    - Lowest cost launch vehicle
    - Increased mass delivery capability
    - Return to Earth capability

Deep  
Impact



DAWN



MAVEN

MARS

2/17/16

# Notional Orbiter Project Lifecycle Planning Timeline

FY 16		FY 17							
Pre-A	Phase A		Phase B	Phase C		Phase D		Phase E	
▲	▲	▲	▲	▲	▲		▲	▲	▲
MCR	P/LAO	SRR/MDR	PDR	CDR	SIR		Launch	Arrival	Science Orbit

Phase A start in 2017 is essential, given that an orbiter arriving at Mars at the earliest opportunity would join Odyssey in its 22<sup>nd</sup> year of service and MRO in its 18<sup>th</sup>

# Next Steps – Path to Orbiter Phase A

## Establish Partnerships

- Communication with iMEWG and MEPAG communities
- Explore potential International & Commercial Partnerships

**by May 2016**

## Prepare for MCR

- Establish baseline project architecture
- Establish key partnerships
- Refine technical trades
- Conduct ORDT, identify opportunities to openly compete selected instrumentation

**Summer 2016**

## Concept Refinement

- Detailed spacecraft studies, assess available aerospace capabilities
- Proceed with Phase A implementation

**Fall 2016+**

ORDT (Objectives & Requirements Definition Team)

# View from our Journey to the Foothills of Mount Sharp



*“compliments of Curiosity rover - Sept 2015”*